

REMARKS

Claims 24-34, 36-39, 41, 46-49, and 51 have been canceled without prejudice. Claims 17, 19, 20, 23, 35, 40, 42 and 50 have been amended. Specifically, claim 17 has been amended to incorporate subject matter of claims 34 and 36; therefore, claim 17 is now merely a combination of previously claimed subject matter and creates no prosecution history estoppel. Claims 19, 20 and 23 have been amended to particularly point out and distinctly claim that the material has a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when a semiconductor has been bonded to a support member using said material. Claims 35 and 40 have merely been amended to depend upon base claim 17. Claim 42 has been amended to particularly point out and distinctly claim providing and bonding steps in a method of bonding a semiconductor chip to a support member. Claim 50 has been amended to recite a semiconductor device comprising (a) a semiconductor chip; (b) a support member; and (c) a material.

Claims 17-23, 35, 40, 42-45, and 50 are pending and are believed to comply with 35 U.S.C. 112. Claims 42 and 51 respectively, being directed to a method and a device, are believed to contain statutory subject matter as defined in 35 U.S.C. 101. Applicants believe that claims 17-23, 35, 40, 42-45, and 50 are in condition for allowance for the following reasons.

No new matter has been added to the present application by this amendment (B).

The Invention

Broadly, the present invention is directed to a material comprising an organic die-bonding film, wherein the material may be used in the field of semiconductor manufacturing. Specifically, in one preferred embodiment of the invention, the material comprises an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin. In other more limited embodiments, the material has a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when bonding a semiconductor to a support member.

In another preferred embodiment of the invention, a method of bonding a semiconductor chip to a support member, the method comprising the steps of: (a) providing a material

comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin; and (b) bonding a semiconductor chip to a support member using the material.

In yet another preferred embodiment of the invention, a semiconductor device includes (a) a semiconductor chip; (b) a support member; and (c) a material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin, wherein the material is provided between the semiconductor chip and the support member.

The main advantage of the material in accordance with the present invention is that, when manufacturing a semiconductor device and the like, there is a dramatic decrease in the number of defects in the material. Specifically, there are fewer reflow cracks (i.e., essentially none, as shown in Tables 1), which equates to a more durable and reliable semiconductor chip.

The Rejection

Claims 42, 50 and 51 stand rejected under 35 U.S.C. 101 as being directed to a “recitation of a use” and not to patentable subject matter. Claims 19, 20, 21, 23 and 34-51 stand rejected under 35 U.S.C. 112, second paragraph, as being indefinite or incomplete claims. Claims 17, 22, 25, 27, 34, 35, 38 and 41-51 stand rejected under 35 U.S.C. 102(b) as anticipated by Morita (U.S. Patent 5,406,124). Claim 28 stands rejected under 35 U.S.C. 102(b) as anticipated by Hozoji (Japanese document JP5-218107). Claims 18, 24, 26, 30 and 32 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Hozoji. Claims 19-21, 23, 29, 31 and 33 stand rejected over 35 U.S.C. 103(a) as unpatentable over Morita. Claims 36 and 39 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Yusa et al. (U.S. Patent 5,667,899).

Applicants respectfully traverse the grounds of rejection for the following reasons:

Applicants' Arguments

As an initial matter, Applicants point out that the Yusa et al. Patent is not valid proper art for the purposes of making a rejection under 35 U.S.C. §103, as stated in § 103© because the Yusa et al. Patent (U.S. Patent 5,667,899) and the instant application were commonly assigned to the Hitachi Chemical Company, Ltd., of Tokyo, Japan, at the time the invention was made in accordance with 35 U.S.C. 103(c). As proof of this fact, Applicants have attached herewith a copy of a Declaration (hereafter the "Matsumota Declaration") under 37 C.F.R. 1.132 by Genichi Matsumota, General Manager, Intellectual Property Office, Hitachi Chemical Company, Ltd., dated December 20, 2001. Although the Matsumota Declaration is directed specifically to U.S. Patent Application No. 09/785,436, filed February 20, 2001, Applicants point out that both Application No. 09/785,436 and the instant U.S. Patent Application No. 09/543,247 are both continuations of U.S. Patent Application No. 08/9981,702, filed March 31, 1998, now abandoned.

Therefore, it is plain that because U.S. Patent Application No. 09/785,436 and U.S. Patent 5,605,763 are commonly assigned to the Hitachi Chemical Company, Ltd. that likewise the present U.S. Patent Application No. 09/543,247 and U.S. Patent 5,605,763 were commonly assigned, at the time the invention was made.

Morita et al. discloses an "insulating adhesive tape" that includes a base supporting film and an adhesive layer formed on at least one surface thereof (see Abstract). The adhesive layer is a thermoplastic polymer comprising a thermoplastic polyimide, wherein the polymer has a glass transition temperature ranging from 180°C to 280°C and an elastic modulus ranging from 10^{10} dyne/cm² to 10^{11} dyne/cm² at 25°C, wherein the elastic modulus includes a value ranging from 10^2 dyne/cm² to 10^9 dyne/cm² at a temperature between 250°C and 300°C. Morita et al. discloses that the thermoplastic polymer has a water absorbing ratio of less than 1.2% (col. 9, lines 14-16); however, Morita et al. does not explicitly state to what the percentage is relative. Specifically, Morita et al. only describes % by weight (col. 9, lines 35-39 and lines 53-55);

therefore, it is suggested that Morita et al. describes that the water absorbing ratio is less than 1.2% by weight. There is nothing in the Morita et al. reference to teach, or even suggest, that the water absorbing ratio is 1.5% by volume or less as required by claims 17, 42 and 50.

Furthermore, Applicants point out that the Examiner admits that Morita et al. does not disclose a “17 degree peel strength of 0.5 Kgf/5mm x 5mm chip or above” (Office Action, dated September 10, 2001, page 9, lines 11-15), but the Examiner asserts that in the absence of unexpected results that such an increase in peel strength would be “ascertainable by routine experimentation and optimization” (Office Action, dated September 10, 2001, page 9, line 16 to page 10, line 5).

Applicants submit for the Examiner a Declaration by Takashi Masuko (hereafter the “Masuko Declaration”), dated March 5, 2002, attached herewith and filed in accordance with 37 C.F.R. 1.132. The Masuko Declaration establishes that when the novel film (see Section 7 on page 3) in accordance with the present invention is compared to the prior art film (see Section 6 on page 3) disclosed by Morita et al. under identical experimental conditions, the result is that the novel film of the present invention demonstrates an “unexpected invulnerability” (page 7, lines 4-8). As shown in Table 2, when evaluating the two films for the occurrence of reflow cracks it was shown that while all of the Morita film samples under the given die-bonding conditions manifested reflow cracks, none of the samples made in accordance with the present invention had reflow cracks. In addition, when peel strength was measured (Masuko Declaration, section 8) the peel strength was significantly greater for the novel film of the present invention over the Morita film (see Table 1). In fact, when the die-bonding condition was set as “ $250^{\circ}\text{C} \times 30\text{gf/mm}^2 \times 20\text{ sec}$,” all of the chips made using the novel film were destroyed during testing because the bond strength was stronger than the chip. In other words, the bond strength of the material in accordance with the present invention was stronger than what this particular test could measure! Clearly, this is another superior and unexpected result.

In addition, Morita et al. does not teach the particular epoxy resin recited in claim 17, or that the component includes polyimide in addition to the epoxy resin as recited in claim 35.

Thus, the Morita et al. reference can not anticipate, or render obvious, the subject matter of base claims 17, 42 and 50, because Morita et al. does not teach, or even suggest, that the water absorbing ratio is 1.5% by volume or less, or the particular epoxy resin. In addition, Morita et al. do not teach that the component includes the epoxy resin and a polyimide as required by claim 35.

However, even if a *prima facie* case of obviousness can be inferred from the teachings of Morita (which it can not) it is plainly shown that the present invention provides superior and unexpected improvements in both peel strength and reflow crack development over the Morita et al. adhesive tape. Specifically, the peel strength of the novel film in accordance with the present invention is consistently and significantly stronger than the peel strength of the Morita et al. film, and in some cases the peel strength of the instant novel film was so strong that it could not be fully measured using the present techniques. In addition, the novel film in accordance with the present invention was “unexpectedly invulnerable” to the formation of reflow cracks, whereas 100% of the Morita films developed reflow cracks.

Hozoji discloses a “resin-sealed semiconductor device” wherein a die pad and a semiconductor element are fixed by using an adhesive layer in which a base material having a low moisture absorption rate (i.e. glass cloth or metal foil) is impregnated or coated with a bisphenol type epoxy resin, wire bonded, and with resin containing one or more of epoxy, phenol or polyimide resins (see Abstract). In addition, Hozoji teaches several desired low water absorption rates being changes in weight over a period of time (see paragraph [0016] and Table 1). Hozoji does not teach that the water absorbing ratio is 1.5% by volume or less as recited in claims 17, 42 and 50.

Conclusion

Applicants have established by filing the Masumoto Declaration that the Yusa et al. Patent can not be used as valid prior art for the purposes of making a rejection under 35 U.S.C. 103. Furthermore, Applicants have shown that the Morita et al. reference and the Hozoji

reference, either alone or in combination, fail to disclose that the material would have a water absorbing ratio is 1.5% by volume or less or would teach the particular epoxy resin recited; therefore, the Examiner's proposed rejection of claims 17-23, 35, 40, 42-45, and 50 is untenable and should be withdrawn. Lastly, even if a *prima facie* case of obviousness could be established (which it can not), the Masuko Declaration clearly establishes that the instant invention provides both superior and unexpected bonding peel strength and an unexpected invulnerability to the formation of reflow cracks.

Applicants assert that the present claims comply with 35 U.S.C. 112 and are in condition for allowance; therefore, Applicants respectfully request reconsideration of the application and a prompt Notice of Allowance is earnestly solicited.

Questions are welcomed by the below signed attorney for the Applicants.

Respectfully submitted,

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17. (Amended) A material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes a component that comprises an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin.

18. (Not amended) A material according to claim 17, having a saturation moisture absorption of 1.0% by volume or less.

19. (Amended) A material according to claim 17, having a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when at a stage where a semiconductor has been bonded to a support member using said material.

20. (Amended) A material according to claim 18, having a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when at a stage where a semiconductor has been bonded to a support member with said material.

21. (Not amended) A material according to claim 20, said material having a modulus of elasticity of 10 MPa or less at a temperature of 250°C.

22. (Not amended) A material according to claim 17, said material having a modulus of elasticity of 10 MPa or less at a temperature of 250°C.

23. (Amended) A material according to claim 22, having a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when at a stage where a semiconductor has been bonded to a support member with said material.

- 24. (Canceled)
- 25. (Canceled)
- 26. (Canceled)
- 27. (Canceled)
- 28. (Canceled)
- 29. (Canceled)
- 30. (Canceled)
- 31. (Canceled)
- 32. (Canceled)
- 33. (Canceled)
- 34. (Canceled)

35. (Amended) A material according to claim 1734, said component including a |
polyimide resin.

- 36. (Canceled)
- 37. (Canceled)
- 38. (Canceled)
- 39. (Canceled)

40. (Amended) A material comprising an organic die-bonding film according to
claim 17, further including an inorganic filler. |

- 41. (Canceled)

42. (Amended) A method of bonding a semiconductor chip to a support member, the method comprising the steps of:

providing a material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin; and

bonding a semiconductor chip to a support member using the material wherein said material comprising an organic die-bonding film according to claim 17 is used for said bonding.

43. (Not amended) A method of bonding according to claim 42, wherein said bonding is carried out at a temperature of 100-350°C for a time period of 0.1 second – 20 seconds with a pressure of 0.1 - 20gf/mm².

44. (Not amended) A method of bonding according to claim 43, wherein said bonding is carried out a temperature of 150 - 250°C for a time period not longer than 2 seconds, with a pressure of 4 gf/mm² or less.

45. (Not amended) A method of bonding according to claim 44, wherein said bonding is carried out for a time period 1.5 seconds or less, with a pressure of 0.3 – 2 gf/mm².

46. (Canceled)

47. (Canceled)

48. (Canceled)

49. (Canceled)

50. (Amended) A semiconductor device manufactured using a material comprising:
a semiconductor chip;
a support member; and

_____ a material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin, wherein the material is provided between the semiconductor chip and the support member an organic die-bonding film according to claim 27.

51. (Canceled)